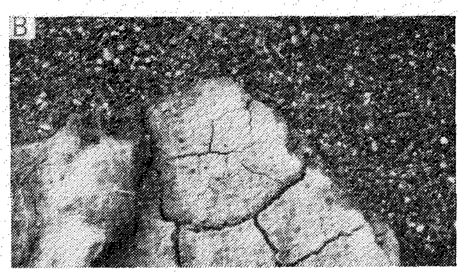

FIG. 3. Section of beach-cliff near Sinaru where ice ramp has caused deposition of gravel. A: Tundra sod and gravel moved by wave action; B: Close-up view of sod and gravel.

CONCLUSION

The ice ramp is probably short-lived because of the intense wave action and the interference of pack ice moving shoreward during the storm. However, in the few hours that the ice ramp exists, a large volume of sand and gravel may be transported and deposited on the tundra surface. Even though this event is brief and only occurs for a short lateral distance, the entire coast would experience this type of ice and wave action over a long period of time. Hence a continuous or semicontinuous gravel unit is deposited above the wave-eroded cliffs.

The presence and method of deposition of the sand and gravel units at the Walakpa site give further evidence that vertical sorting has not occurred. This in turn suggests that the artifacts found in an occupation level belong only to that occupation level; i.e., the tool assemblages found can be attributed to a single period of cultural deposition. The observations are of extreme importance to the unravelling of the archaeological sequence along the arctic coast of Alaska.

Owing to the uncommon occurrence of this phenomenon the author has only pieced together the sequence of events necessary for the deposition of these gravel units. However, they have been observed by Silas Negovanna who is a native of the area (personal communication).

ACKNOWLEDGEMENTS

The support for the summer research of 1969 was provided by the Arctic Institute of North America (contract ONR-410a). John M. Campbell of the Department of Anthropology, University of New Mexico, was the principal investigator.

The author extends thanks to the Naval Arctic Research Laboratory for field support during this investigation. The director, Dr. Max Brewer, the Assistant Director, John Schindler, and the staff of N.A.R.L. were extremely helpful.

The author also wishes to thank Dennis Stanford, the field researcher of the Walakpa site for his assistance during the 1969 field season and Silas Negovanna for his observations of the phenomenon discussed in this paper.

James O. Duguid
Department of Civil and Geological Engineering
Princeton University
U.S.A.

REFERENCES

[1]Corte, A. E. 1961. The Frost Behavior of Soils: Laboratory and Field Data for a New Concept: 1. Vertical Sorting, *U.S. Army Cold Regions Research Engineering Laboratory, Research Report* 85, 22 pp.

[2]Tedrow, J. C. F. 1966. Polar Desert Soils, *Soil Science Society of America Proceedings*, pp. 381-87.

[3]Hume, J. D. and M. Schalk. 1964. The Effects of Ice-Push on Arctic Beaches, *American Journal of Science*, 252: 267-73.

Microclimate and Plant Growth at Isachsen and Mould Bay*

In discussing the botany of the northwestern Queen Elizabeth Islands[1] I noted that the available climatic data did not suggest a significant difference between the summer climate of Isachsen and of Mould Bay; yet Mould Bay harbours plant species that are absent from Isachsen, and specimens from there are less depauperate than those from Isachsen. It seemed probable that Mould Bay, which is better protected from winds off the Arctic Ocean, might have less of the very low stratus that often covers Isachsen and which

*Contribution No. 835, Plant Research Institute, Canada Department of Agriculture.

TABLE 1. Hours of sunshine in summer at Isachsen and Mould Bay.

	1968			1969			1970		
	June	July	Aug.	June	July	Aug.	June	July	Aug.
Isachsen	279.3	287.5	124.9	283.6	137.4	?	77.5	295.3	192.9
Mould Bay	364.9	362.0	134.7	244.3	172.8	103.0	129.7	387.9	227.2
Mould Bay surplus (hrs.)	85.6	74.5	9.8	—39.3	34.4	?	52.2	92.6	34.3
Mould Bay surplus (%)	30.6	25.8	7.9	—13.8	25.7	?	67.2	31.3	17.8

must pass less sunlight than do sheets of high stratus and altostratus. The available data on cloud cover, which do not include cloud height and which are inevitably somewhat subjective, indicated no marked difference between the stations, and sunshine records were lacking for both.

With three years' bright sunshine data now available for Isachsen and Mould Bay, I have extracted the summer figures from the Monthly Record of Meteorological Observations in Canada (Table 1). The growth period at Isachsen extends from mid June to early August, and July is clearly the critical month. The Isachsen total for August 1969 is missing, but for the other 8 months Isachsen exceeded Mould Bay only once. The Mould Bay excess for July was 25 per cent or more in each year. Although soil surface and screen temperatures differ little at Isachsen on heavily overcast days, thermograph records kept by D. St-Onge showed[1] that on predominantly sunny days the soil surface maxima exceeded the screen maxima by 20-30°F. (11-17°C.). Thus modest differences in total bright sunshine can be very important to plant growth in this region where almost all activity is confined to the lowest 10 cm. of air and much of it to the lowest 3 cm. A longer record is needed before we can fully accept a higher July sunshine figure for Mould Bay; but if the three years of record are nearly representative they must go far in explaining the better growth at this station. However, there is a distinct possibility that diffuse sunlight through thin cloud, not registered by the Campbell-Stokes recorder, adds to Mould Bay's advantage.

D. B. O. Savile
Plant Research Institute
Central Experimental Farm
Ottawa

REFERENCE

[1]Savile, D. B. O. 1961. The botany of the northwestern Queen Elizabeth Islands. *Canadian Journal of Botany*, 39: 909-42.

A Freshwater Budget of the Gulf of Boothia, Northwest Territories

A freshwater budget for the Gulf of Boothia (here considered to include Prince Regent Inlet) was estimated from oceanographic data available for the Canadian Arctic using a formula derived by Tully[1]:

$$C = 1 - \frac{\int_0^L S(z)\,dz}{S^*L}$$

where C is the fraction of freshwater to the depth L, L is the depth at which the salinity attained S* or the depth to the bottom if the salinity there was less than S*, S(z) is the salinity at depth z and S* is the base salinity, in this budget taken to be 33.8‰. For each station occupied in 1961 and 1962 the amount of freshwater in metres, CL, was obtained. The result for 1962 is shown in Fig. 1.

Sources of freshwater include direct precipitation, runoff, advection of less saline water and of ice, and condensation at the surface. It may be removed by evaporation and advection. We assumed that condensation is so small it may be neglected and that the rates of precipitation and evaporation are the same over the land as over the water. The mean precipitation in the region of the Gulf of Boothia is usually less than 20 cm./year[2,3] and in nearby Barrow Strait it was estimated[4] that the evaporation was about 8 cm./year in 1962. If the latter value is representative of the Gulf of Boothia and its drainage basin, the excess of precipitation over evaporation is about 12 cm./year. The estimate is supported by 1965 streamflow measurements of the Back River[5]; for this basin the excess of precipitation over evaporation is about 17 cm./year. It seems that the water surplus for the Gulf of Boothia drainage basin is somewhat less[6] so the estimate of 12 cm./year appears reasonable. As the area of the drainage basin is one and one quarter that of the gulf, runoff would add 15 cm./year to the freshwater of